Methods of Quantifying Uncertainty - Uncertainty DRI Workshop
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Broad questions for group discussion:

In what ways is uncertainty quantified in different disciplines?

- Seafloor properties
- Oceanography
- Acoustics
- Signal processing

How might uncertainty be "transferred" between disciplines?

What are useful reduced-dimension representations for environmental parameters which provide compact bases meaningful for sonar performance prediction purposes?

Seafloor Properties

There was some extended discussion attempting to distinguish between uncertainty (e.g. measurement error) and variability (e.g. natural – driven by geologic processes). The experimentalist observes them combined together but it is useful to consider them separately since their spatial structure (e.g. correlation properties) can be different.

Understanding the geologic processes involved is critical in order to estimate the relevant spatial scales for deriving a spatial sampling strategy.

Oceanography

Vertical coherence can be surprisingly short resulting in a large number of vertical EOF modes necessary for representing variability. However, this level of fidelity in representing the oceanographic processes might not be necessary for end-to-end sonar system performance characterization. Thus, an important discussion at the interface between oceanography, acoustics, and signal processing is determining appropriate reduced-dimension representations of the spatial structure and time-evolving dynamics of the oceanography. We need to discover how to transform oceanographic probability density functions (PDF's) into performance PDF's. Of necessity, we need to consider various levels of simplification in these representations (e.g. using covariances instead of complete joint PDF's).

Alternatives to a detailed representation of the oceanography should be considered. For example, a major features model (e.g. fronts) and their seasonal transitions might be sufficient to distinguish between significantly different sonar performance regimes.

Acoustics

Need to determine useful representations of variability at the output of acoustic models based on characterizations of environmental variability rather than just the deterministic component of the field from a known environment as is typically done. Although generating these joint PDF's always can be done via Monte Carlo simulation, a more computationally effective approach is needed.

Signal Processing

A major theme of this program is how characterizations of the natural variability of the environment can be transferred through to uncertainty in sonar system performance. Thus, and end-to-end perspective is critical. It will be important both to understand the impact of uncertainty on existing (generic) sonar systems as well as to derive new signal processing approaches that incorporate characterizations of uncertainty into their design.